PEDESTRIAN AND BICYCLE COUNT DATA COLLECTION AND USE

A GUIDE FOR LOUISIANA

AUGUST 2019

LTRC Project 16-4SA: Pedestrians and Bicyclists Count:
Developing a Statewide Multimodal Count Program

Appendix D

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1. INTRODUCTION

Government Street Pilot Count, Baton Rouge, October 2017

Government agencies at all levels across the nation are increasingly interested in adopting a "complete streets" approach to infrastructure development by implementing or upgrading facilities for walking, bicycling, and transit use. The complete streets approach represents a substantive shift in how infrastructure is planned, constructed, and evaluated to accommodate multiple modes of transportation.

In Louisiana, the Department of Transportation and Development (DOTD), as well as numerous local governments, have adopted complete streets policies to guide efforts to develop streets that are safe and functional for people of all ages and abilities, no matter how they need or choose to get around. Increasingly, cities, towns, and parishes around the state are investing in improved infrastructure for people walking and bicycling, such as sidewalks, bike lanes, and trails.

Evaluation of the efficacy of these investments—and planning and prioritizing future investments—requires new and innovative approaches to data collection and analysis in order to effectively measure infrastructure demand and performance for all user groups, including pedestrians and bicyclists. Understanding how many people are traveling on foot or by bicycle on Louisiana's roadways is critical to understanding transportation patterns and trends, identifying appropriate, context-sensitive interventions, and evaluating safety outcomes.

However, while motor vehicle counts are conducted regularly throughout the state, most communities have little or no data available about how, when, and where people are walking or bicycling on their roadways. Methods for collecting bicycle and pedestrian count data vary, and few states have yet developed coordinated statewide active transportation data programs to support policy implementation and benchmarking.

ABOUT THIS GUIDE

In 2016, the Louisiana Transportation Research Center initiated a study, *Pedestrians and Bicyclists Count: Developing a Statewide Multimodal Count Program,* to research best practices and available methods and technologies for measuring active transportation activity (e.g. bicycling, walking, and other human-powered modes of travel), in order to provide DOTD (as well as local and regional agencies) with guidelines for conducting coordinated counts and utilizing data for planning and performance measurement.

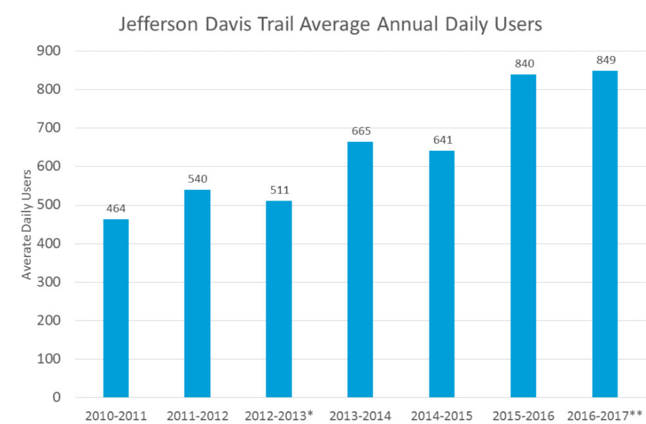
This guide represents a synthesis of the findings of that research effort, and is intended to provide a practical introduction to documenting pedestrian and bicycle activity to any local or regional entity interested in initiating or expanding pedestrian and bicycle data collection and/or to align methods with any future state-led count efforts. In addition, it may be of use to non-profit organizations and advocates engaged in data collection. The guide includes:

- ◊ An overview of commonly-used and recommended count technologies and methods;
- ◊ Step-by-step instructions for initiating an active transportation count program; and
- ◊ Preliminary guidance for managing and using count data collected.

Available resources, specific planning needs, and data applications will vary from one place to another, but it is the intent of this guide to summarize best practices and provide a foundation for communities across the state to coordinate efforts to better understand and plan for safe, complete, active, and livable streets.

Complete Streets and Pedestrian/Bicycle Data in Louisiana

- ◊ In 2009, DOTD convened a Complete Streets Work Group, resulting in the adoption of Louisiana's first Complete Streets Policy and the development of a final report outlining recommended actions, including data collection.
- ◊ As of April 2018, at least 13 parishes and municipalities have adopted or are working on a pedestrian, bicycle, and/or trail master plan to guide future investment
- ◊ Louisiana MPOs, including the Capital Region Planning Commission and the New Orleans Regional Planning Commission (NORPC), have already begun collecting automated pedestrian and bicycle count data. Notably, NORPC's Pedestrian Bicycle Resource Initiative has collected manual and automated counts in Orleans, Jefferson, and St. Bernard Parishes since 2010 , finding that bicycle volumes have increased sharply at many locations where new facilities have been completed, and tracking an overall year-over-year 14% annual increase in trail users at one long-running count location



Source: *Greater New Orleans Pedestrian and Bicycle Count Report, 2017*

WHY COUNT?

The need for more and higher quality pedestrian and bicycle volume data, similar to that which has been available for decades for motor vehicles, has been well-documented by transportation professionals and agencies, including the Federal Highway Administration (FHWA), which has moved toward a data-driven approach to funding and performance measurement.

Government agencies, researchers, and communities have initiated pedestrian and bicycle count programs for a variety of reasons, including:

- ◊ To track changes in overall active transportation trends (volumes as well as behavioral) over time
- ◊ To understand spatial variation in user volumes across a geographic area and determine existing travel patterns
- ◊ To plan for and prioritize future infrastructure investments
- ◊ To develop more nuanced extrapolation factors for estimating volumes from short-duration counts
- ◊ To benchmark progress toward transportation and/or public health policy goals
- ◊ To evaluate the impacts and/or efficiency of previous investments
- ◊ To make applications for funding to support active transportation more competitive
- ◊ To incorporate into next-generation travel demand and network analysis models

Importantly, as more communities invest in infrastructure for walking and bicycling and more people travel by these modes on our roadways, it is critical that we are able to holistically understand safety impacts and outcomes. Without count data, most jurisdictions lack the ability to accurately evaluate risk for vulnerable road users. Counts can be used to normalize crash data and estimate crash rates relative to the number of people walking and bicycling, which may increase sharply as facilities are added or improved.

Federal Guidance for Pedestrian and Bicycle Activity Monitoring

- ◊ FHWA Traffic Monitoring Guide - the latest edition of this handbook includes, for the first time, guidelines for nonmotorized traffic monitoring, including recommendations for data management and integration with the Travel Monitoring Analysis System (TMAS)
- ◊ NCHRP 797: Guidebook on Pedestrian and Bicycle Volume Data Collection - this report describes count methods in detail and provides recommendations for count program implementation, including example applications
- ◊ NCHRP Web-Only Document 229: Methods and Technologies for Pedestrian and Bicycle Volume Data Collection: Phase 2 - builds on and updates Report 797 with additional research and emerging technology
- ◊ NCHRP 770: Estimating Bicycling and Walking for Planning and Project Development: A Guidebook - provides best practice for estimating and modeling non-motorized trips and routes

2. METHODS AND MATERIALS

This section provides an overview of the basic types of counts and data collection methods, as well as the types of technologies which are available to collect data in different contexts. It also provides an overview of basic data collection principles for pedestrian and bicycle counts, which differ in key ways from traditional motor vehicle count practices.

It is important to note that this is an evolving field of practice: new technology is being developed rapidly, and, at present, there are no federal or state requirements for non-motorized traffic monitoring. Methods vary widely among jurisdictions. This guide is intended to summarize the most commonly used and/or promising approaches currently in use and provide broad guidelines which can be flexibly applied to a variety of potential technologies and contexts.

TYPES OF COUNTS

In the broadest terms, pedestrian and bicycle counts can either be collected **manually** with human observers in the field or reviewing video data, or using **automated** technology to capture counts continuously over periods of 24 hours or more. They may be **short** in duration (one hour to several months) or **long-term/**permanent. Counts can either collect user volumes passing a specific point along a roadway **segment**, or total volumes or specific types of movements through an **intersection**.

The FHWA Traffic Monitoring Guide and National Cooperative Highway Research Program (NCHRP) recommend that a comprehensive multimodal count program include a mix of short and long-duration counts, and identify appropriate roles for both manual and automated methods. Each community must select a count approach that meets their specific needs and available resources.

University of New Orleans Student conducts manual pedestrian and bicycle count, New Orleans, 2015

Manual Counts

Manual counts, conducted by trained paid or volunteer observers in the field (or remotely reviewing video camera footage), have been used widely for local count data collection, including in Louisiana. Of all count methods, manual counts offer the lowest barrier to entry: start up costs are low, technical expertise needed is limited, and a relatively large number of count locations can be covered quickly and inexpensively. Manual counts are useful to track overall trends over time, demonstrate user demand, compare different types of facilities or locations, and understand demographic and behavioral characteristics of users. However, small sample sizes limit the utility of this data for most statistical analyses, and it can be cumbersome and cost-prohibitive to scale up these counts to broadly cover a street network.

The National Bicycle and Pedestrian Documentation Project defined the first standardized technique for manual counts and has been widely utilized and adapted, including in Louisiana by the NORPC's Pedestrian and Bicycle Resource Initiative, which provides a useful model for collecting and using manual count data in Louisiana.

There is no definitive federal guidance for manual counts, but the FHWA Traffic Monitoring Guide (TMG) recommends a minimum of 4-6 hours of count data during peak periods (typically, morning and evening weekday commute periods; weekend mid-day), with 12 hours of total count time preferred. Unless substantial, relevant long-term automated count data is available to develop site-specific adjustment factors (See section 4), extrapolation of manual count data to estimate pedestrian or bicycle Average Annual Daily Traffic (AADT) is not recommended.

Manual Count Summary

Best for:

- ◊ Understanding user demographics and behaviors
- ◊ Community-based evaluations
- ◊ Collecting data for a large number of locations
- ◊ Intersections and other hard-to-count locations
- ◊ Validating automated count data accuracy

Key limitations:

- ◊ High labor demand
- ◊ Limited data applications
- ◊ High degree of variation/unreliability
- ◊ Typically cannot be used year-round

Estimated Cost: Very low (if using volunteer labor), though coordination and data management costs may be prohibitive for large-scale count programs

Examples: New Orleans Regional Planning Commission Pedestrian and Bicycle Count Program, Washington State Bicycle and Pedestrian Documentation Project

Automated Counts

Compared to manual counts, automated counts provide significant advantages in terms of data applications and per-hour costs of data. Increasingly, local and state agencies involved in pedestrian and bicycle data collection are switching to primarily automated count programs, with manual counts in a supporting role to validate and prepare for automated counting, fill in gaps in count coverage over a priority network, and/or enrich and contextualize findings with qualitative information.

The most common automated, mechanical count technologies for counting pedestrians and/or bicyclists include: pneumatic **tubes, infrared sensors, and inductive loop counters.** In addition, video-based automated data analysis is an area of rapid growth and enormous potential to solve challenges of data collection for intersections, locations that do not currently have dedicated pedestrian and/or bicycle infrastructure, and other hard-to-count contexts. Keeping up with progress in this field and new products as they evolve and are tested for suitability for planning purposes will be imperative moving forward.

Finally, an array of less-commonly used count technologies exist. These typically have a limited range of use-cases, have not yet proven to be cost-effective, or are simply too new to have much supporting research documenting their accuracy or reliability, but may be useful in meeting the needs of specific situations. A table of both common and less widely used technology types, including information about specific products and vendors, appears at the end of this section. However, this guide focuses on tried-and-tested options which are ready for immediate, reliable use.

Pneumatic Tube Counters

Pneumatic Tubes and Infrared Sensors, Tulane Avenue, New Orleans, July 2017

Widely used for motor vehicle counts, pneumatic tube counters may also be used to collect bicycle volume data. These devices, in which one or more tubes are stretched across a right-of-way, record when vehicles pass over and depress the tubes. Counters can be bicycle-specific, or may record and differentiate among multiple categories of road user, including bicycles. Some models also provide speed data. Research has found that counters developed specifically for bicycle counting, however, tend to be more accurate.

Pneumatic counters are relatively low-cost, easy to install, highly portable, and appropriate for conducting counts on trails, dedicated bikeways, and mixed-traffic lanes. They are suitable for short to medium-term deployment (2 weeks to 2 months on shared roadways, or up to a year or more on bicycle-only facilities). Tube counters are not recommended for high-volume mixed-use roadways, as repeated impacts from motor vehicles (particularly heavy trucks or buses) will wear out the tubes, requiring frequent maintenance or replacement. However, they are a versatile, easy to deploy option for collecting robust data for on– or off-street bicycle facilities and understanding daily user patterns and volumes.

Pneumatic Tube Counter Summary

Best for:

- ◊ Short-duration counts on bike lanes, cycletracks, low-volume shared roadways
- ◊ Collecting counts at multiple locations on a limited budget
- ◊ Conducting preliminary counts prior to installing permanent counters

Key limitations:

- ◊ Tubes wear out quickly in mixed traffic conditions
- ◊ Regular maintenance required for longer counts
- ◊ Not suitable for locations where bicyclists' movements are unpredictable (e.g. many sidewalk riders)

Estimated Cost: Approximately $1,500—$2,800 per unit, plus $300 per set of (bicycle-specific) replacement tubes

Examples: LTRC "Pedestrians and Bicyclists Count," Vermont Bicycle and Pedestrian Program

Passive Infrared Counters

Infrared (IR) counters (either passive IR, which senses heat of people passing through the detection field, or less commonly active IR which detects breaks in an infrared beam) may be used to count combined volumes of pedestrians and bicyclists on facilities which do not permit motor vehicle travel, but cannot distinguish between user types unless combined with other technology. They generally cannot be used to count on-street bicyclists.

Infrared counters tend to systematically undercount users, particularly on very busy facilities, largely due to occlusion when users travel in groups or side-by-side. However, they are easy to install and portable for short duration counts, or may be left in place for long term or permanent counts, with little maintenance required other than periodic calibration. Infrared counters are appropriate for measuring pedestrian volume on sidewalks as well as total user volume on shared-use paths or trails, or at "pinch points" that funnel users past a particular location (e.g., bridges).

Passive Infrared sensor in housing, Lafitte Greenway, New Orleans 2017

Passive Infrared Counter Summary

Best for:

- ◊ Measuring pedestrian volume on sidewalks
- ◊ Lower-cost permanent counts on off-street bicycle facilities or shared-use trails

Key limitations:

- ◊ Cannot distinguish between pedestrians and bicyclists
- ◊ Cannot be used on-street

Estimated Cost: $2,000—$6,000 per unit (depending on range and housing of sensor)

Examples: New Orleans' Lafitte Greenway; San Diego Association of Governments

Inductive Loop Detectors

Inductive loops, which are installed within or on the surface of the pavement to detect bicycle activity through the disruption of their electromagnetic field by metallic objects, are also commonly used in motor vehicle monitoring and can be used to count bicycles in either restricted or shared bicycle/motor vehicle facilities. On a restricted facility (i.e., trail or sidepath), these can be combined with an infrared sensor to calculate pedestrian and bicycle traffic independently. They may also be installed in shared travel lanes, although accuracy has been found to be reduced.

Inductive loops require saw cuts to the pavement to install on existing facilities or can be placed directly in the base course under concrete for new construction, making them suitable only for long-term data collection efforts. Careful installation and calibration is required, particularly in mixed traffic conditions, to ensure that sensor sensitivity is set correctly and occlusion errors are minimized.

Installation of Inductive Loop Detector, Tammany Trace, Mandeville, 2014

Inductive Loop Detector Summary

Best for:

- ◊ Long-term counts on cycletracks and dedicated conventional or buffered bike lanes
- ◊ Long-term counts on shared-use paths or trails (combined with an infrared sensor to differentiate modes)

Key limitations:

- ◊ Electrical/engineering expertise required for installation
- ◊ Accuracy decreases in mixed traffic conditions

Estimated Cost: Approximately $2,500—$4,300 per unit, not including installation costs

Examples: Tammany Trace (Mandeville), Colorado DOT Pedestrian and Bicycle Continuous Counts

Automated Video-Image Processing

Using automated video technology for bicycle and pedestrian counting programs is relatively new but has shown significant promise. Through the use of a camera and computerized algorithms, automated video counting systems can collect and catalog data instantaneously, potentially simultaneously providing data for all travel modes and allowing data collection in locations where road configurations, user behaviors, or other factors make the use of traditional methods difficult or impossible.

Research on such technologies has increased significantly in the past five years with algorithms becoming more sophisticated and accuracy rates increasing, with several vendors emerging offering services ranging from processing of data from existing (compatible) cameras to full-service turn-key products that include cameras, software setup, and data management.

In the future, it is anticipated that this technology (including open-source or low-cost processing software) will become more widely available and affordable, with many practitioners predicting an ever-increasing share of data collection will employ these methods. At present, most available products and services are recommended primarily for pilot study use, so that additional research on their efficacy can be conducted.

University of New Orleans Student manually reviews pedestrians and bicycle count video footage, 2017

Automated Video-Image Processing Summary

Best for:

- ◊ Intersection and turning movement counts
- ◊ Areas without dedicated bike/ped infrastructure or unpredictable user behaviors
- ◊ Counting all modes of traffic simultaneously

Key limitations:

- ◊ Technology is still emerging; limited research on available products
- ◊ Relatively complex installation requirements
- ◊ Programming expertise required to calibrate and process data
- ◊ Not suitable for poorly lit contexts

Estimated Cost: Varies widely; full-service vendors typically charge on a monthly subscription basis, plus equipment, software, and/or installation costs

Examples: Jacksonville, FL (Numina partnership); Chicago, IL (Miovision)

Emerging and Less-Common Count Technologies

In addition to the commonly used tools described above, additional technologies have been found to meet non-motorized count program goals in specific locations and contexts. Meanwhile, new technologies for data collection are emerging. While the research has shown that so far, none of these yet offer clear advantage over the previously noted sensor types in terms of data quality and cost-effectiveness, the following products have been used to collect pedestrian and bicycle volume data in one or more locations:

- *Piezoelectric strips* are a pair of strips of material that are laid on the surface of or underground which produce an electric signal when deformed. These can be installed permanently, though some vendors have developed an easier to install, temporary version of this product that offers similar benefits and limitations to pneumatic tubes.
- *Radar sensors* can be installed underground or on a post to capture pedestrians and/or bicyclists. These can be permanently or temporarily installed. This is an emerging field of technological development, so far best suited for applications similar to infrared sensor technology.
- *Thermal sensors* which are mounted above an area offer promise of capturing both total counts and movements of users, using similar technology to video processing. These are likely to be most useful for permanent count locations, as they require external power and appropriate mount locations. More research is needed on the accuracy or limitations of this technology.
- *Fiberoptic Sensors* can detect changes the amount of light transmitted based on the amount of pressure applied to a fiberoptic cable. These can potentially be applied in any paved area. This has been used in Europe but so far very limited testing has been conducted in the U.S. and installation costs are relatively high.
- *Laser scanners,* often used to detect presence indoors, capture details about activity based on reflected laser pulses and could also be utilized for screenline counts in areas with no horizontal obstructions where electrical power supply is available.
- *Acoustic (pedestrian only) or pressure (bicycle and pedestrian) pads* installed in the ground to detect weight may be useful for unpaved trails or for establishing pedestrian demand where sidewalks currently do not exist, but appear to be of minimal use in typical count contexts.
- *Magnetometers* can detect (but not distinguish among) metallic objects that impact the magnetic field (e.g., bicycles or cars) and may be useful in certain trail contexts.
- *Off-the-shelf Products* developed for unrelated purposes may also be employed to conduct counts, such as the use of Microsoft Kinect devices to conduct pedestrian counts. Such applications present similar challenges as video imaging, but in an “off-the-shelf” format that requires minimal technical expertise.

CHARACTERISTICS AND USE-CASES FOR COMMONLY USED PEDESTRIAN AND BICYCLE COUNT TECHNOLOGIES

Characteristic	Passive Infrared	Active Infrared	Pneumatic Tubes	Inductive Loops	Passive IR + Inductive Loops	Automated Video	Manual Counts
Types of Users Counted							
All	X	X			X	X	X
Pedestrians only					X	X	X
Bicycles only			X	X	X	X	X
Pedestrians AND bicycles					X	X	X
Bicycles AND autos			X	X		X	X
Characteristics Collected							
Different user types					X	X	X
Direction of travel	X	X	X	X	X	X	X
User characteristics						X	X
Types of Sites							
Shared-use trails	X	X	X	X	X	X	X
Sidewalk segments	X	X			X	X	X
Bike lane segments			X	X		X	X
Cycle track segments		X	X	X		X	X
Shared roadway segments			X	X		X	X
Roadway crossings		X	X	X		X	X
Intersections/turning movements						X	X
Count Durations							
Long duration/permanent	X	X		X	X		
Short duration	X	X	X			X	X
Resources Required							
Equipment cost	Med	High	Med	Med	High	Med	Low
Preparation/planning costs	Med	Med	Med	High	High	Med	Low
Installation costs	Low	Med	Low	High	High	Med	n/a
Ongoing/maintenance costs	Low	Low	Med	Low	Med	High	High

SELECTED VENDORS AND PRODUCTS (AS OF SPRING 2018)

Technology Type	Vendor	Product	Est. Price Per Unit
Pneumatic Tubes	Eco-Counter	TUBES	$2,200-$2,800
	MetroCount	RidePod BT	$1,700
	Jamar	TRAX Cycles Plus	$1500 - $1700 + $1500 software cost
	Waycount	Waycount Road Tube Traffic Counter	$499 (protected bikeways only)
Passive Infrared	Eco-Counter	PYRO	$2000 - $6,600
	Jamar	Scanner	$2000-$3000
	EcoCounter	CITIX -IR	$5000 - $8500
Inductive Loops	Eco-Counter	Urban ZELT/Greenway ZELT	$2500 - $4300
	AADI/Aanderaa	Datarec 7, Datarec 410, Datarec Loop Monitor	Variable
	Counters & Accesso-ries (CA-Traffic)	Bicycle Recorder	Variable
	Eco-Counter	Easy ZELT (Temporary)	$2700 - $5400
Mixed Infrared/ Inductive Loop	EcoCounter	EcoMULTI	$4100 - $6,600
Video Image-Based Sensors	Numina	Numina	$1,600 -$5,000 + monthly fee
	Miovision	Scout/Datalink	Variable
	Placemeter, Inc.	Placemeter	Variable
	Econolite	Autoscope Cyclescope	Variable
	Migma	MigmaMidblock/ MigmaPedCount; Migma Bicycle	$3,340
	Motionloft	ViMO Sensor	Variable
	Iteris	Smart Cycle; PedTrax	Variable
Piezoelectric Strips	MetroCount	RidePod BP	$4,200
	RoadSys/Q-Free	Hi-TRAC CMU/HI-TRAC CMU Cycle Priority	Variable

A Note on Vendor Selection:

The majority of robust count programs, operated at any level of government, including all automated data collection efforts currently underway in Louisiana, are currently working with **Eco-Counter** brand products, the clear industry leader for the main categories of pedestrian and bicycle count equipment, due to the following attributes of the company and its product lines:

- ◊ Easy accessibility of data
- ◊ Remote (GSM) data retrieval functionality
- ◊ Excellent customer service
- ◊ Robust performance record

For continuous/permanent count station development, these products appear to offer consistent long-term value. For short-duration counting, this company's products are generally not the least expensive, but are all specifically designed for pedestrian and bicycle data collection and to be user-friendly and durable, which has made them similarly popular.

On the other hand, jurisdictions new to non-motorized volume monitoring appear more likely to experiment with emerging products and less-tested vendors, particularly those who offer turn-key solutions and less up-front investment for a set quantity of data.

Regardless, technologies are constantly evolving (particularly for video-based counts: new equipment should not be discounted simply because extensive validation has not been conducted or published. Ultimately, technology and vendor selection must be made in accordance with individual agency resources and goals.

Pedestrian and Bicycle Monitoring Basics

The Traffic Monitoring Guide outlines a model count program supported by research and best practices with which local and statewide count programs should endeavor to align. However, no state or region has fully implemented a program of the scale described, as this model supposes a sizeable set of permanent monitoring stations plus a larger, rotating array of short-term count sites similar to how states systematically monitor motor vehicles. Incremental progress toward systematic monitoring through both state-level coordination and compatible local and regional data collection is needed.

At present, there is no single "one size fits all" solution that is appropriate for all types of contexts, budgets, intended data uses, and overall community goals. Rather, most jurisdictions employ multiple methods and sometimes, multiple vendors, to comprise a suite of tools (including indirect data from GPS sources, surveys, etc.) to fit a variety of situations for both short and long-duration data collection.

Regardless of the specific technology or product selected, it is important to understand that pedestrian and bicyclist volumes are more difficult to effectively count and model than motor vehicles. Their movements are less constrained and predictable (e.g., pedestrians crossing outside of crosswalks; bicyclists riding on both the street and sidewalk), overall volumes at most locations are much smaller, and their travel patterns tend to be far more variable and sensitive to an array of environmental factors. Unlike for motor vehicles, a simple 24- or 48-hour count is unlikely to yield data reliable enough to make inferences about year-round trends, even if robust permanent count station data did exist.

Once data is collected, validating, cleaning, and interpreting data also requires different protocols and processes relative to motor vehicle counting. As no set standard for data validation and quality assurance exists, agencies should define criteria and establish data management standards appropriate to their capacity and needs.

10 Principles of Pedestrian and Bicycle Counting

1. People walking and bicycling are sensitive to weather, traffic conditions, and more: non-motorized user volumes are more variable than motor vehicles
2. The scale of data collection is smaller than for motor vehicles in most places, and there is less historical data available
3. Pedestrian and bicyclist volumes do not directly correspond to functional class and/or motor vehicle ADT
4. People bicycling and walking can behave unpredictably and are more difficult to predict, detect, and count than motor vehicles
5. All count technology has inherent systematic and site-specific error which must be adjusted for
6. Establishing at least one permanent count location is recommended as a foundation for understanding your data
7. A minimum of 7 days (14 preferred) is recommended for short-duration automated counts
8. Short duration counts should be conducted in Spring and Fall if possible, during periods of reasonably good weather
9. Manual counts are still needed for validating sensors, collecting demographic and behavioral data, filling gaps in what automated sensors can capture, and more
10. Routine maintenance, validation, data cleaning, management, and usage protocols must be established

3. DEVELOPING A COUNT PROGRAM

This section outlines recommended best practices step-by-step in planning a non-motorized traffic volume data collection program, highlighting key steps and decisions which will impact program success. Much of these findings stem from guidance in the *Traffic Monitoring Guide*, which now includes guidance for non-motorized users and which the literature indicates is the preferred model for state agencies engaged in non-motorized monitoring (although as noted earlier, this outlines an ideal scope and processes which may be unrealistic for most transportation agencies).

PLANNING TO COUNT

The first questions to answer when preparing to collect pedestrian and bicycle data include:

- What data has already been or is currently being collected?
- What is the purpose of the data collection, and what kinds of data are required to meet planning, policy, or programmatic needs?
- What resources are available for implementation?

A review of any existing count programs, locations, and equipment in a jurisdiction, including counts collected by other agencies, should include:

- Evaluation of count locations and site selection criteria;
- Equipment or methods utilized and identified limitations or assessments of those methods;
- How the data is being utilized and by whom; and
- Identified data gaps and priorities.

If existing continuous count data is available, this may be evaluated to provide preliminary guidance about typical traffic patterns in various contexts, which can support the development of factor groups for short-term counts.

Identifying the overall purpose and specific goals of a count program is a critical early step, as it will impact methodology, site selection, and processing needs. For example, a local jurisdiction seeking to evaluate demographic and behavioral trends or identify countermeasures at a high-crash intersection may be best served by limited manual or video-based counts, while a state or regional agency seeking to develop factor groups for systematic monitoring or determine mode share along a specific corridor would require longer-duration automated screenline counts.

SITE SELECTION

Site selection criteria should be developed with program goals in mind. Ideally, this begins with identifying seasonal traffic pattern (“factor”) groups. In areas where limited or no data has previously been collected and factor groups are not yet well-defined, initial counts may be more exploratory in nature or linked to specific research questions, e.g., before-and-after an infrastructure change. Siting strategies may include:

- **Random** or (more commonly) **stratified random sampling** of count locations representative of specific characteristics
- **Representative locations** selected for being presumed to be typical of prevailing non-motorized traffic patterns for a given set of characteristics (factor groups). Note that these should not simply be locations expected to have the highest pedestrian or bicycle volume
- **Targeted locations** such as bridges or other “pinch points,” existing or planned bike/ped facilities, high-crash locations, previous count locations, etc. Note that it is generally not advised to make generalizations about a larger community based solely on these locations
- **Control locations** to allow a more accurate understanding of the effects of a specific intervention, counts at similar locations not directly affected by the project are recommended.

Practitioners recommend generating a list of potential site locations based on existing counts, interests of collaborating stakeholders, and logistical feasibility, then developing a tracking system for potential site locations and selection criteria that includes the following site characteristics:

- Priority
- Coordinates
- Area type
- Anticipated travel pattern/factor group
- Location ownership/jurisdiction
- Existing infrastructure
- Appropriate count type/method/duration
- Local jurisdiction contact information

Prior to selecting final count locations, a site visit to prospective count sites should be conducted to document the location for technical constraints, general baseline activity levels, and other site specific factors. In addition, testing for interference from utilities or other metallic objects is strongly recommended, particularly where inductive loops are intended. In any case, a clearly articulated set of count site selection criteria are essential to planning and funding count activities and effectively interpreting data.

COUNT DURATION AND TIMING

Federal guidance recommends that a well-developed non-motorized count program will include a mix of continuous and short-duration count locations (both cyclical and project-specific) similar to the programs maintained by DOTs for motorized vehicle monitoring. Specifically, the TMG suggests an ambitious 3 to 5 permanent monitoring stations per factor group, while simultaneously acknowledging that non-motorized count programs, particularly at the local level, are likely to be more limited in scope and budget.

Regardless, implementation of at least one permanent count location is strongly recommended in order to provide basic information about year-round patterns and overall trends. Often, a shared-use trail is the easiest facility type to begin counting, though permanent count sites can be effective anywhere considered reasonably representative of the type of users and trips about whom data is needed.

On the other hand, short term counts can help better understand spatial variation in terms of safety, infrastructure, etc. There is no definitive guidance for how many short-duration count sites are needed; again, this will be based on budget and need. A mix of project-specific counts and cyclical short term counts conducted annually or biennially is recommended.

At a minimum, short-term (automated) counts should include at least seven days of continuous data in order to minimize variation error, with a strongly preferred duration of two weeks, particularly in the case of inclement weather. These counts should generally be conducted at times of the year with high expected user volumes and minimal variability, although there may be circumstances where counts are desired at other times of the year (e.g., special events or time-sensitive project evaluations).

Generally, in Louisiana, fall and spring months yield desirable conditions for active transportation, though long-term count data should be consulted if available to confirm periods of consistent activity. Whenever counts are conducted, weather condition data should be recorded, including:

- Whether precipitation fell during data collection
- Approximate high temperature for count duration/day
- Approximate low temperature for count duration/day

Prior to the implementation of a permanent count site, a short-duration count (either manual or automated) should also be conducted if possible in order to confirm that data is consistent with expectations .

What Will This Cost? Breaking Down Estimated Program Costs

Importantly, there is no universal standard for how much funding is needed to support statewide pedestrian and bicycle monitoring. Programs can be scaled to fit available resources, and typically grow incrementally over time. Broadly speaking, a count program can expect to incur the following categories of costs:

- **Capital costs**
  - Long-duration or permanent counters range in cost from about $2,000 to $7,000 per unit (infrared sensors on the lower end of the range, and sensors which are capable of counting pedestrians and bicycles separately at the higher end).
  - Temporary/mobile count units commonly in use range from $1,000 to $4,000 per unit, depending on sensor range, data intervals required, etc.
  - Installation - installation costs (other than staff time) are typically only required for permanent count units requiring engineering expertise (e.g. inductive loops). Many transportation agencies have in-house capacity to complete installation or can partner with another governmental entity that has this capacity; if outside contractors are required, installation costs of $1,000 - $2,000 per unit may be anticipated (though per unit costs may decrease with scale).
- **Operational costs** - Maintenance, supplies, vendor/subscription costs
  - Maintenance - Over time, wear and tear of count equipment can be expected. Units should be durable for all kinds of weather and to minimize vandalism; however, intermittent costs for replacement of major components, cleaning, etc. should be considered.
  - Supplies - including routine costs for replacement batteries, tubes, installation hardware, etc. These costs will vary based on how heavily individual count units are used
  - Vendor/subscription costs - this may range from fees associated with automatic data transmission (e.g., EcoCounter, $400/unit per year modem cost), web platforms for analyzing data (may be included), to full-service data solutions (e.g., Numina's $100/month cost data subscription).
- **Personnel costs -** Practitioners recommend an established program should dedicate at least the equivalent of one full-time staff person to bike/ped data collection (States, MPOs, and larger cities); time may be split among team members with different roles (e.g., program coordination, installation/maintenance, and data analysis). Smaller programs should dedicate staff time as needed to conduct periodic maintenance, data retrieval, and reporting tasks.

EQUIPMENT SELECTION

Once count locations and parameters have been identified, these count sites may be matched to existing equipment inventories or planned purchases. In many cases, equipment specifications must be tailored to site needs (e.g., inductive loops of the correct size). Many count programs employ more than one type of technology and method, and may utilize multiple vendors or models in order to meet different contextual needs, which can complicate data management.

For all technology types, the following characteristics must be considered in order to match equipment to the desired count location:

- ◊ Sites where users are constrained to the area being measured
- ◊ Peak hour user volume
- ◊ Mix of user types/ability (or need) to differentiate pedestrian and bicyclist traffic
- ◊ Detection zone width
- ◊ Vehicular traffic presence and flow
- ◊ On straight, smooth, level sections of roadway or trail (not on a curve or steep grade)
- ◊ Facility surface/water/debris
- ◊ Away from potential sources of interference (e.g., water, direct sunlight for infrared sensors, utility lines for inductive loop detectors)
- ◊ Adjacent land uses/near major access points (for shared-use trails as well as key activity generators such as schools)
- ◊ Social environment characteristics (e.g., bus stops, doorways, obstructions, locations where users are unlikely to linger in place
- ◊ Mounting devices available, if needed
- ◊ Security from theft and vandalism

In addition, agencies should consider technical considerations such as battery life, overall product life, data downloading requirements, and software options/compatibility (e.g., compatibility with FHWA TMAS).

Some jurisdictions may be able to use existing (newer model) motor vehicle count equipment, if carefully calibrated and validated to meet accuracy targets, although most practitioners recommend use of products specifically designed to capture pedestrian and bicycle activity

INSTALLATION & MAINTENANCE

Obviously, installation needs will vary based on the specific type and model of sensor selected. Manufacturer instructions should be followed to ensure successful installation. Broadly, however, the following considerations should be observed:

- ◊ Conduct a field visit to the location to observe how traffic flows through the area and any potential challenges for monitoring
- ◊ Avoid areas with poor drainage or that are prone to flooding
- ◊ Observe best practices for work site safety, including safety vests and goggles, cones or barricades, etc.
- ◊ Plan installation for times and days when impacts to traffic (all modes) will be minimized
- ◊ If installing a bicycle count sensor, bring a bicycle to the site for testing
- ◊ For pneumatic tube counters, a variety of fasteners are available. It is recommended to have a few options on hand to match according to the roadway surface type, traffic volumes, etc. Road nails with figure-8 fasteners work well for many contexts, for example, but may not be suitable for new or soft asphalt, or very hard concrete. Mastic tape secures well, but can reduce the life of the tubes.

UNOTI team repairs pneumatic tube sensor, Tulane Avenue, New Orleans, 2017

◊ Be sure to position tube counters where cars are not likely to park on top of the tubes, as this will interfere with data collection. Temporary closure of on-street parking spaces may be needed, while signage indicating the purpose and duration of the count has been found to reduce errors due to obstructed tubes.

◊ Wood housings/posts for infrared sensors are NOT recommended for Louisiana due to their vulnerability to water and insect damage. Choose waterproof plastic and metal components where possible

◊ Position any sensor housing out of direct sunlight - extreme temperatures have been found to result in erratic counts for infrared devices

◊ Ensure that anti-theft and vandalism mechanisms are in place and secured and debris is removed before leaving site.

Maintenance protocols will also vary depending on the equipment deployed. In general, pneumatic tubes will require the most frequent maintenance, especially in mixed traffic conditions (at least once per week). All permanent equipment should be inspected at least every three months to check for damage and remove any debris, insect habitat, or potential obstructions from the vicinity.

CALIBRATION AND VALIDATION

Regardless of technology selected, an immediate check for functionality and to calibrate the device if necessary (such as by adjusting sensitivity) should be conducted. The initial validation can simply involve manual observation of at least 10 bicyclists and/or pedestrians, just to ensure that the sensor is working as expected.

A second test should be conducted a few days after installation, through either manual observation or review of video footage. Recommendations for how much validation is needed vary, from a minimum of two hours, to up to 30 hours, if data is “binned” in hourly increments. The duration of validation counts will vary based on:

◊ The bicycle/pedestrian activity level at the site (a minimum of 100 users of each mode is a good baseline on which to assess accuracy)

◊ The duration of the count overall (more validation is warranted for a new permanent counter which will form the foundation of data extrapolation and analysis than for a 2-week project-specific count)

◊ Unique characteristics of the count location where additional data is needed to adjust for contextual issues (e.g., users outside of sensor field)

Some degree of error is inherent in all automated count technology, particularly systemic undercounting (largely due to occlusion). These errors can be adjusted with calibration equations. Other types of errors may include blocked sensors, users bypassing the sensor, equipment malfunction, extreme temperatures, and lighting.

It is the responsibility of the implementing agency to set standards for accuracy that will meet the needs of their count program and any related policy goals. Periodic, ongoing checks of permanent count sites should also be conducted, generally once per year, or if there are any significant changes at the count location.

Potential Funding Sources for Pedestrian and Bicycle Counts

Non-motorized transportation monitoring can, and has been, supported by a wide variety of funding types. State-level investment, often through university partnerships, is common, especially in early stages of program implementation. Each of the following is a potentially eligible source for program support:

Federal: *A variety of federal transportations can support data collection for non-motorized transportation, either as a standalone program, or, more frequently, as a component of a larger planning of infrastructure project. Incorporating data collection into evaluation and performance measurement elements of project-specific applications is one strategy for incrementally growing local data collection where a comprehensive program is not yet feasible (e.g., installing a permanent counter on a new shared-use trail). Specific funds FHWA has identified as being suitable for bike/ped monitoring-related costs include:*

- ◊ Transportation Alternatives Set-Aside funds
- ◊ Highway Safety Improvement Program (HSIP)
- ◊ Section 402 (State and Community Highway Safety Grant Program)
- ◊ Federal Transit Administration Capital Funds (FTA)
- ◊ Associated Transit Improvement set-asides (ATI)
- ◊ National Highway Performance Program (NHPP)
- ◊ Surface Transportation Block Grant Program (STBG)
- ◊ Recreational Trails Program
- ◊ Statewide Planning and Research (SPR)
- ◊ Metropolitan Planning Funds (PLAN)

State and Local: *States and municipalities can support data collection in a variety of ways to meet their needs and resources/capacity. Typically, states and cities engaged in bike/ped data collection support dedicated staff (either full time or as a component of one or more existing staffers' job description, including planning/managerial and field staff) and allocate funds to program operations and maintenance through one or more of the following:*

- ◊ General funds
- ◊ Sales tax revenue
- ◊ Bond issues
- ◊ Tax-increment financing

Private: *Partnerships among agencies and community partners are key to building data collection programs, including the following:*

- ◊ *Philanthropic Foundations* - Several jurisdictions have received private grant funds from philanthropic organizations sponsor specific investments (e.g., count equipment).
- ◊ *Health care providers* - programs intended to encourage physical activity and/or provide data supporting the evaluation of health outcomes can be an appealing sponsorship opportunity for health-focused organizations
- ◊ *Universities* - University partnerships are commonly employed to implement new count programs and support research related to the data collected
- ◊ *Developers* - municipalities can ask developers to conduct counts aligned with preferred local methods on streets impacted by proposed developments as part of the permitting process, helping to incrementally build a base of public data.

4. PUTTING COUNT DATA TO WORK

This section outlines preliminary principles for managing and applying data for planning purposes. As transportation planning and funding become ever more data-driven and outcome-oriented, local and state agencies will be expected to justify investments with quantitative data and clear performance benchmarks. Pedestrian and bicycle count data can help ensure that active modes of transportation aren't left behind.

EVALUATING THE DATA (QA/QC)

Quality assurance/quality control (QA/QC) is essential to any traffic monitoring activity. As discussed above, a variety of factors can impact the quality of data, and the existing procedures for QA/QC for motor vehicles cannot be directly transferred to nonmotorized datasets due to the lower average volumes and much greater variability of pedestrian and bicycle activity.

The following basic steps should be conducted with nonmotorized count data:

1. **Chart and visually inspect data:** Check the data for unusually high or prolonged zero counts and identify whether these can be explained by unusual events or circumstances (e.g., inclement weather, holidays) or should be excluded as errors
2. **Determine criteria for assessing outliers:** It is important to note that as bike/ped data tends to be more sensitive and variable than motor vehicle count data, standard processes for excluding outliers (e.g., based on standard deviation) probably will not translate effectively, and more manual review of data is likely to be needed.
3. **Utilize professional judgement** and context knowledge/research to make decisions about which data to include and exclude from the dataset.
4. **Document all editing decisions** and retain a copy of the raw dataset. Once any errors have been flagged and removed, if needed (for example, to allow for development of AADT figures), the data may be cleaned by adding imputed values based on previous counts or regression models.
5. Using manual or video review counts, **evaluate the accuracy** of the data by one or more of the following:
   - ◊ Overall error/average percent deviation (APD): the overall divergence from perfect, observed accuracy, including both over- and under-counts
   - ◊ Average of the absolute percentage difference (AAPD): a measure of consistency of the data (the lower the better)
   - ◊ Pearsons correlation coefficient R - value

ADJUSTING THE DATA

It is not feasible to collect long-term count data throughout a network. Often, short-term counts are simply conducted during periods thought to represent "typical" activity levels, which is sufficient for some planning purposes. However, many of the potential applications of count data require the extrapolation of short-duration count data into an Average Annual Daily Traffic (AADT) estimate through one or more adjustment factors based on findings from relevant, long-term count data from another location in the same "factor group," i.e., a location with similar land use, traffic patterns, and physical characteristics.

There is no clear consensus about the best way to factor data. However, the general process for correcting and adjusting data to use for broader purposes includes the following basic elements:

- ◊ Cleaning the data to identify any errors, outliers, or anomalies
- ◊ Developing site-level data correction factors (accounting for both sensor over and undercounts, as well as users "missed" by the sensor, e.g., bicyclists on sidewalk instead of the street)
- ◊ Use those factors to correct the data to more closely represent true user volumes
- ◊ Develop factor groups based on user volume profiles and other characteristics
- ◊ Expand short-term count data to annual volumes using extrapolation factors based on groupings. Again, methods vary widely based on availability of data, but the general process for this step includes the following components:
    - Evaluate time pattern variations by hour of the day, day of the week, and by month to determine how much seasonal variation exists
    - Compute monthly average traffic and monthly factors (by factor group, if available)
    - Develop hour of day adjustment factors to convert partial-day counts and impute missing data
    - Develop day of week adjustment factors

An example of how these adjustments can be made to account for sensor error, site-specific user behaviors, and weather/temporal variation in user volumes to infer AADT for short-duration counts can be found in the final project report for LTRC Project 16-4SA: Pedestrians and Bicyclists Count. - Developing a Statewide Multimodal count Program.

COUNT DATA MANAGEMENT

Once data has been evaluated and cleaned, it is important to store and maintain this data in a manner which is both useful for immediate applications and future research or analyses. Traffic volume and mode share data are important for numerous applications, but typically not stored or collected as precisely as motorized data.

Data may be integrated with auto traffic count data through a linked database, and practitioners are encouraged to be consistent with the data format and specifications outlined for inclusion in the Traffic Monitoring Analysis System (TMAS), which has recently been updated to allow bicycle and pedestrian point data to be stored and shared via this national platform, so as to facilitate inter-jurisdictional collaboration and the development of a compatible statewide database.

Count data, along with metadata documenting how data has been collected, validated, and cleaned, may then be distributed to other end users, and if desired, to a public interface for archived data, such as Portland's "Bike Ped Portal" and Delaware Valley RPC's user-friendly online count database.

COUNT DATA APPLICATIONS: EVALUATING SAFETY

Count data is considered a key "missing piece of the puzzle" for researchers and practitioners seeking to measure, understand, and improve bicycle and pedestrian safety and comfort in communities across the country. In addition to providing valuable information about general trends and changes over time and/or across different locations or facility types, one of the key uses of pedestrian and bicycle volume data is to better understand whether investments in infrastructure and/or programming make an impact on safety outcomes.

In sufficient quantity, count data expands our ability to measure the degree to which pedestrians or bicyclists are exposed to risk, so as to calculate whether any given facility is more or less safe than another, relative to the number of people who are bicycling or walking there.

Common operational definitions of exposure include:

- ◊ Pedestrian or bicycle volume (AADT)
- ◊ The sum of total flows (both motorized and nonmotorized) passing through an intersection
- ◊ The product of pedestrian or bicycle volume and vehicle volume
- ◊ The square root of that calculated product
- ◊ Estimated crossing distance
- ◊ Estimated travel distances
- ◊ Estimated travel time
- ◊ Number of trips made
- ◊ Area population
- ◊ Active mode share (via Census or travel survey)

At present, there is no clear state or federal guidance for how to evaluate pedestrian and bicyclist exposure; therefore, efforts to evaluate progress toward safety goals are often limited. An FHWA-funded study aimed at filling this gap is currently underway.

At present, most communities lack adequate historical data from which to confidently develop the adjustment factors discussed above. o the limited extent that it is presently available, count data may be used to pilot improvements to analytic methodologies employed. As the body of count data (particularly, year-round continuous counts) expands, Louisiana's ability to comprehensively evaluate exposure and quantify safety impacts will be correspondingly improved.

In order to evaluate the safety impacts of an intervention, it is essential to isolate the effects of that intervention, accounting for any other treatments or enforcement activities, changes in all modes of traffic volume, or other underlying trends through regression analysis.

Two basic study designs may be employed, depending on the nature of the intervention, and the availability of data (especially before and after volume data, but also detailed facility data, and crash data):

- ◊ **Before and After studies** - note that these may not account for some biases unless a reference or comparison group is utilized, and if crash frequency is low, statistical significance may be difficult or impossible to evaluate
- ◊ **Cross sectional studies** - requires a relatively similar group of locations, some of which received an intervention and some that did not. This is the preferred method when lacking sufficient volume and crash data.

Collection of the following data points provides communities with the ability to, at a minimum, describe apparent trends, identify potential areas of concern, and apply lessons learned to the planning, prioritization, and implementation of future projects:

- ◊ A minimum of one week of high-quality (i.e., error free or minimal error) continuous count data (preferably two weeks, during spring or fall, and absent extreme weather conditions) from a reasonably representative location within the study corridor, corrected for systemic error
- ◊ Relevant 365-day count data from a comparable location (i.e. in the same region and factor group), from which to extrapolate counts and derive AADT
- ◊ Post-intervention count data of similar duration and quality. If no relevant permanent count data is available, post-intervention counts should be conducted during the same time of the year, to facilitate direct comparison/minimize impacts of external variables
- ◊ Updated motor vehicle AADT estimates for the same segment, both before and after the intervention (preferably, conducted in coordination with bike/ped counts)
- ◊ Crash data for all modes for a minimum of three years prior to the intervention, as well as any crash data available post-intervention
- ◊ Documentation of any major changes in land use, corridor operations (e.g. changes to signalization, red light photo enforcement), area population, or other factors which may impact user volumes or safety outcomes

5. SELECTED ADDITIONAL RESOURCES

Manuals and Guidebooks

- National Bicycle and Pedestrian Documentation Project (Alta Planning + Design)
- Nonmotorized Travel Analysis Toolkit (FHWA)
- Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts (FHWA)
- Guide to Bicycle and Pedestrian Count Programs (Initiative for Pedestrian and Bicycle Innovation/Portland State University)
- Guidebook for Developing Pedestrian and Bicycle Performance Measures (FHWA)
- Developing a Rubric And Best Practices for Conducting Counts of Non-Motorized Transportation Users (Utah DOT)
- Minnesota Bicycle and Pedestrian Data Collection Manual (MnDOT)

Example Count Program Documentation

- BikeArlington Bicycle & Pedestrian Counters
- Practice Findings from the Columbus Pedestrian and. Bicyclist Data Collection Pilot Project
- Delaware Valley Regional Planning Commission Pedestrian and Bicycle Counts
- Conducting Bicycle and Pedestrian Counts- A Manual for Jurisdictions in Los Angeles County and Beyond.
- Washington State Pedestrian and Bicycle Miles Traveled Project
- Puget Sound Regional Council Bicycle Counts
- Colorado DOT Bicycle and Pedestrian Counts

General Resources

- Pedestrian and Bicycle Data Collection Final Report (FHWA)
- Bureau of Transportation Statistics. Bicycle and Pedestrian Data: Sources, Needs, and Gaps
- Monitoring Bicyclist and Pedestrian Travel and Behavior: Current Research and Practice (FHWA)
- Synthesis of Methods for Estimating Pedestrian and Bicyclist Exposure to Risk at Areawide Levels and on Specific Transportation Facilities (FHWA)